

	<u>Page</u>
Figure 3-1 Relationship between pressure and head	3-3
Figure 3-2 Piezometer tube in a pipeline	3-4
Figure 3-3 Plotting differential - length piezometer data in the determination of equipotential pressure lines	3-6
Figure 3-4 Pressure on submerged surfaces	3-7
Figure 3-5 Relationship between energy forms in pipe and open channel flow	3-17
Figure 3-6 Pipe flow energy relationships	3-23
Figure 3-7 Culverts with inlet control	3-31
Figure 3-8 Culverts with outlet control	3-34
Figure 3-9 Culvert water depth relationships	3-36
Figure 3-10 Various types of open-channel flow	3-40
Figure 3-11 Channel energy relationships	3-43
Figure 3-12 The specific energy diagram	3-45
Figure 3-13 Sharp-crested weir	3-49
Figure 3-14 Broad-crested weir	3-50
Figure 3-15 Submerged weir	3-50
Figure 3-16 Flow through an orifice	3-52
Figure 3-17 Submerged orifice	3-54
Figure 3-18 Types of weirs	3-54
Figure 3-19 Profile of a sharp-crested weir	3-55
Figure 3-20 Rectangular contracted weir	3-56
Figure 3-21 Suppressed weir in a flume drop	3-57
Figure 3-22 Cipolletti weir	3-58
Figure 3-23 90° V-notch weir	3-59
Figure 3-24 Parshall flume	3-60
Figure 3-25 Trapezoidal flume	3-62
Figure 3-26 Stage-discharge curve for unlined irrigation canals	3-64
Figure 3-27 Pipe orifice	3-66
Figure 3-28 Orifice coefficients	3-67
Figure 3-29 Measuring flow by the California pipe method . .	3-68
Figure 3-30 Required measurements to obtain flow from vertical pipes	3-69
Figure 3-31 Required measurements to obtain flow from horizontal pipes	3-70

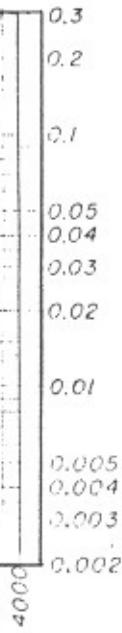
Tables

Table 3-1 Values of Manning's, n	3-22
Table 3-2 Values of Hazen-Williams C	3-22
Table 3-3 Entrance loss coefficients	3-35

Exhibits

		<u>Page</u>
Exhibit 3-1	Water volume, weight and flow equivalents	3-71
Exhibit 3-2	Pressure diagrams and methods of computing hydrostatic loads	3-72
Exhibit 3-3	Required thickness of flashboards	3-74
Exhibit 3-4	Head loss coefficients for circular and square conduits flowing full	3-75
Exhibit 3-5	Discharge of circular pipes flowing full. Manning's n	3-76
Exhibit 3-6	Solution of Hazen-Williams formula for round pipes	3-83
Exhibit 3-7	Friction head loss in semirigid plastic irrigation pipelines	3-84
Exhibit 3-8	Head loss coefficients for pipe entrances and bends	3-89
Exhibit 3-9	Headwater depth for concrete pipe culverts with inlet control	3-91
Exhibit 3-10	Headwater depth for CM pipe culverts with inlet control	3-92
Exhibit 3-11	Head for concrete pipe culverts flowing full with outlet control	3-93
Exhibit 3-12	Head for CM pipe culverts flowing full with outlet control	3-94
Exhibit 3-13	Elements of channel sections	3-95
Exhibit 3-14	Solution of Manning's formula for uniform flow	3-96
Exhibit 3-15	Discharge for contracted rectangular weirs	3-100
Exhibit 3-16	Discharge for Cipolletti weirs	3-103
Exhibit 3-17	Discharge for 90° V-notch weirs	3-106
Exhibit 3-18	Discharge from circular pipe orifices with free discharge	3-107
Exhibit 3-19	Flow of water from vertical pipes	3-108
Exhibit 3-20	Flow of water from horizontal pipes	3-109
Exhibit IN-3-5	Discharge of circular pipes flowing full. Manning's n	3-82a-e

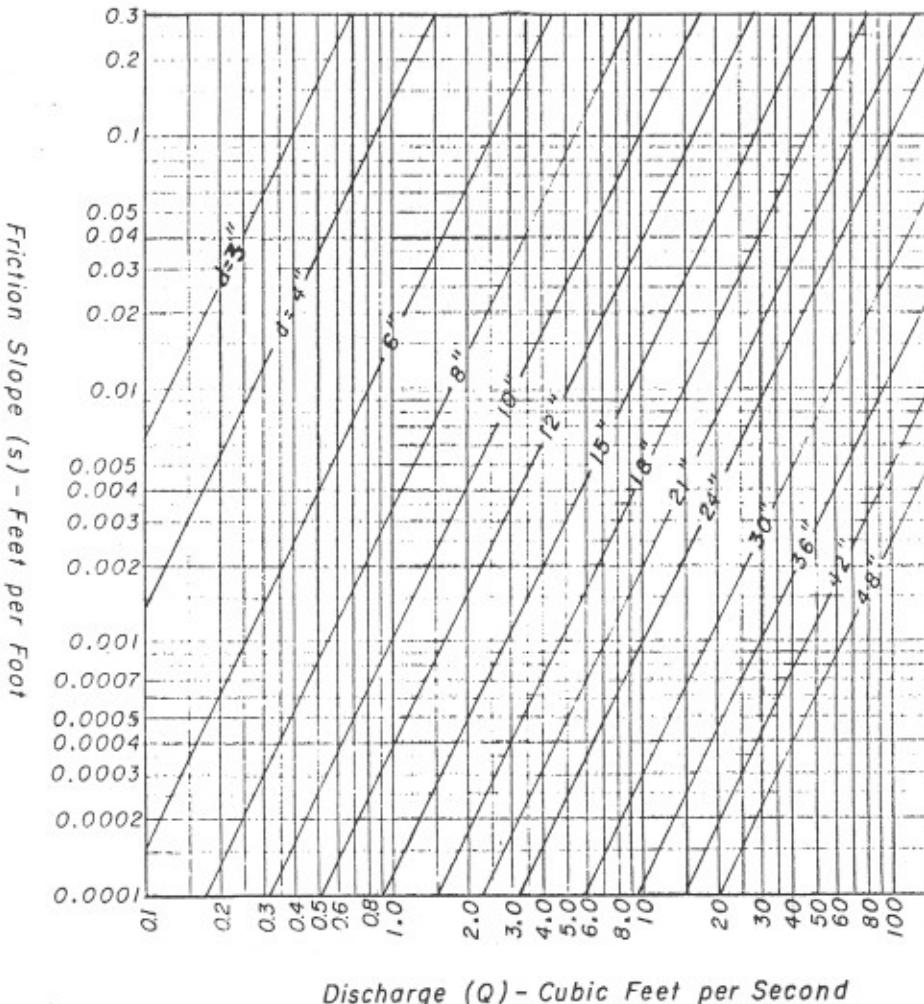
Friction Slope (s) - Feet per Foot'



$$n = 0.009$$

$$Q = \frac{0.000614}{n} \frac{d_i^{8/3}}{s^{1/2}}$$

Q = Discharge of pipe (cfs)
n = Manning's roughness coefficient
s = Friction loss per foot of pipe
d_i = Inside diameter of pipe (in.)



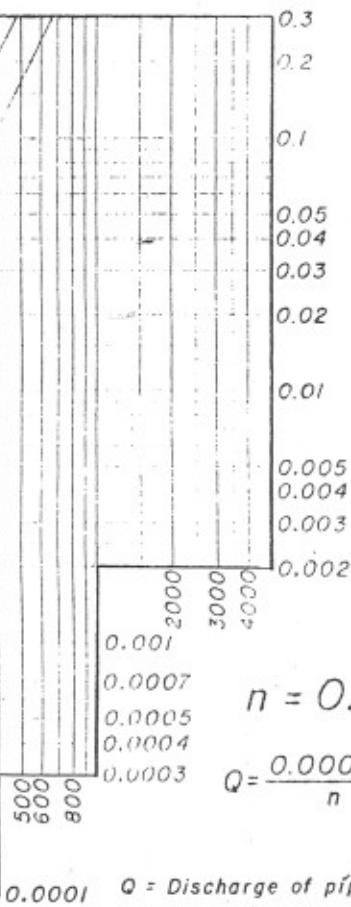
Discharge (Q) - Cubic Feet per Second

Exhibit IN-3-5a *DISCHARGE OF CIRCULAR PIPES FLOWING FULL*

Manning's *n* = 0.009

(Sheet 1 of 5)

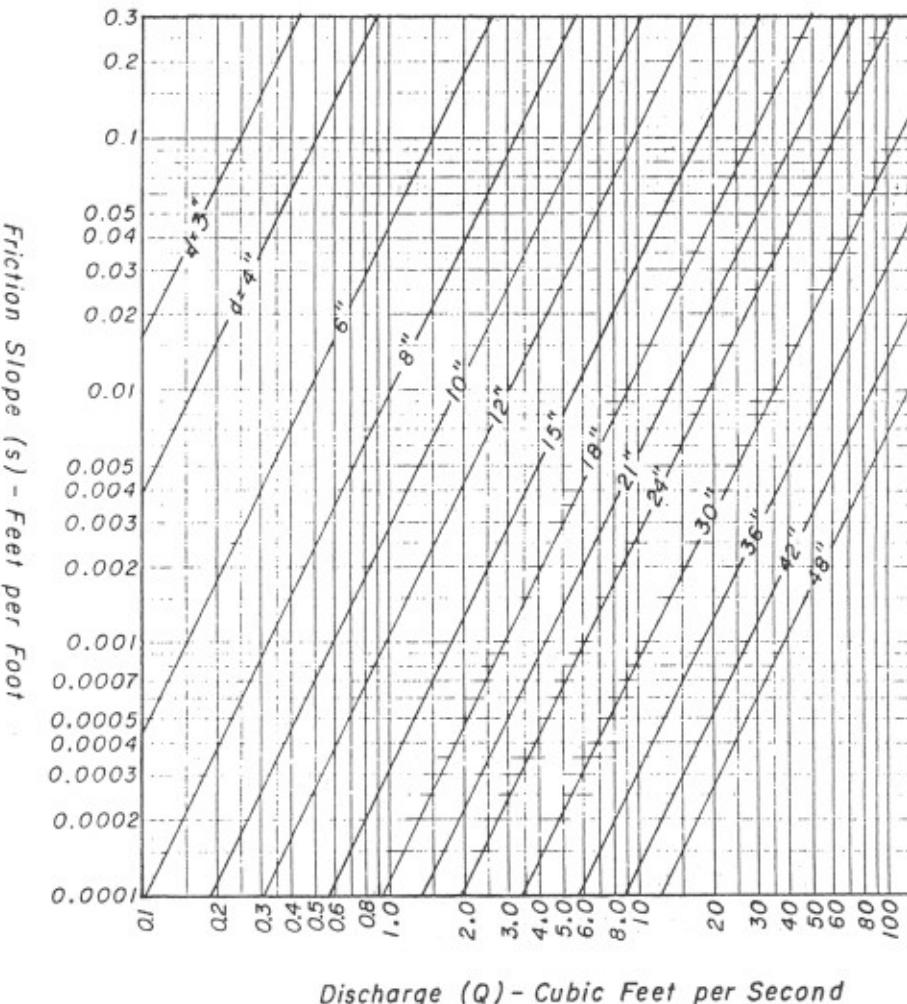
Friction Slope (*s*) - Feet per Foot



$$n = 0.015$$

$$Q = \frac{0.000614}{n} d_i^{8/3} s^{1/2}$$

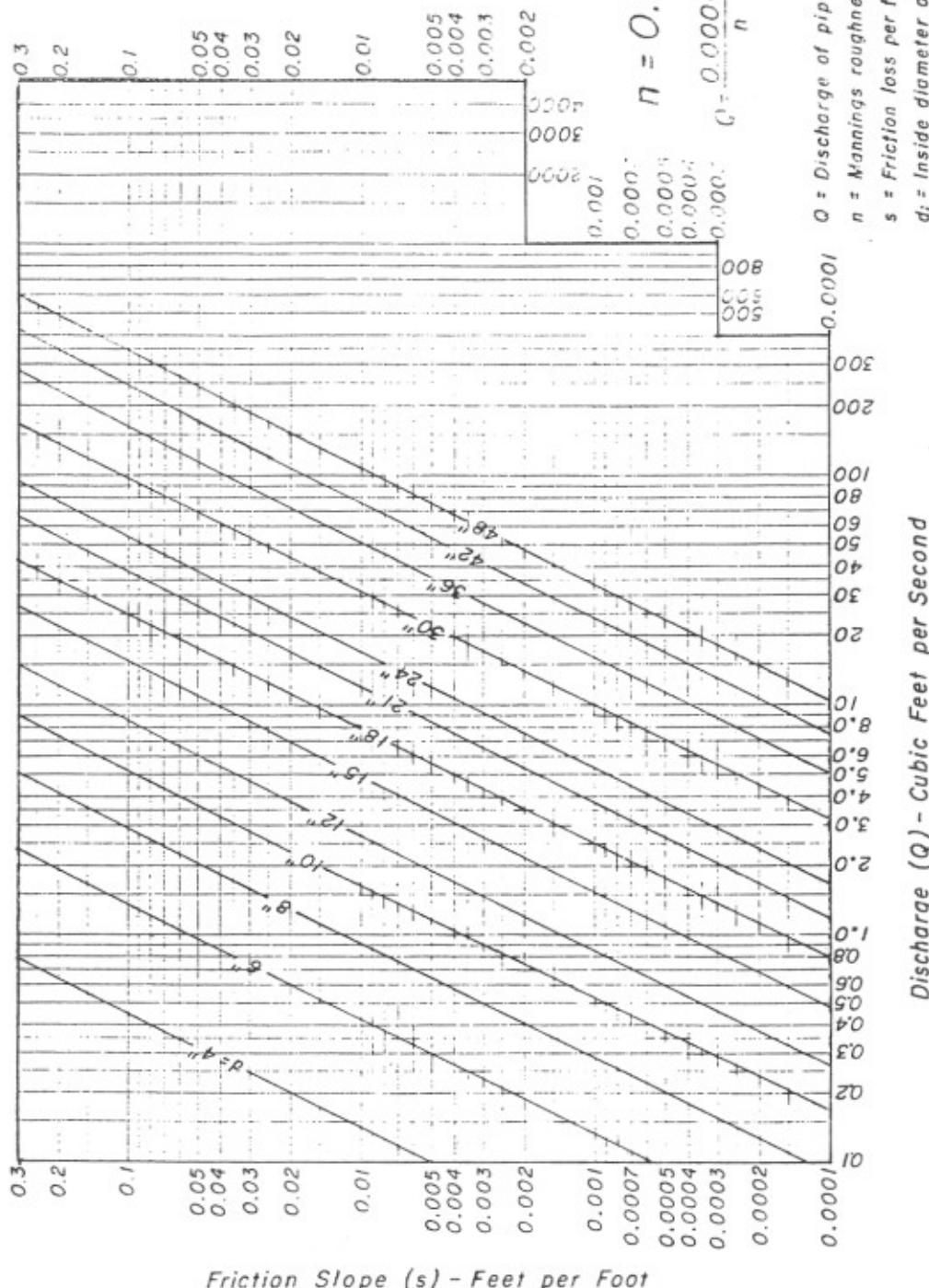
Q = Discharge of pipe (cfs)
n = Manning's roughness coefficient
s = Friction loss per foot of pipe
d_i = Inside diameter of pipe (in.)



IN-3-5a DISCHARGE OF CIRCULAR PIPES FLOWING FULL

Manning's *n* = 0.015

(Sheet 2 of 5)

Friction Slope (s) - Feet per FootFriction Slope (s) - Feet per Foot

-3-5a DISCHARGE OF CIRCULAR PIPES FLOWING FULL

Manning's $n = 0.017$

(Sheet 3 of 5)

3-82d

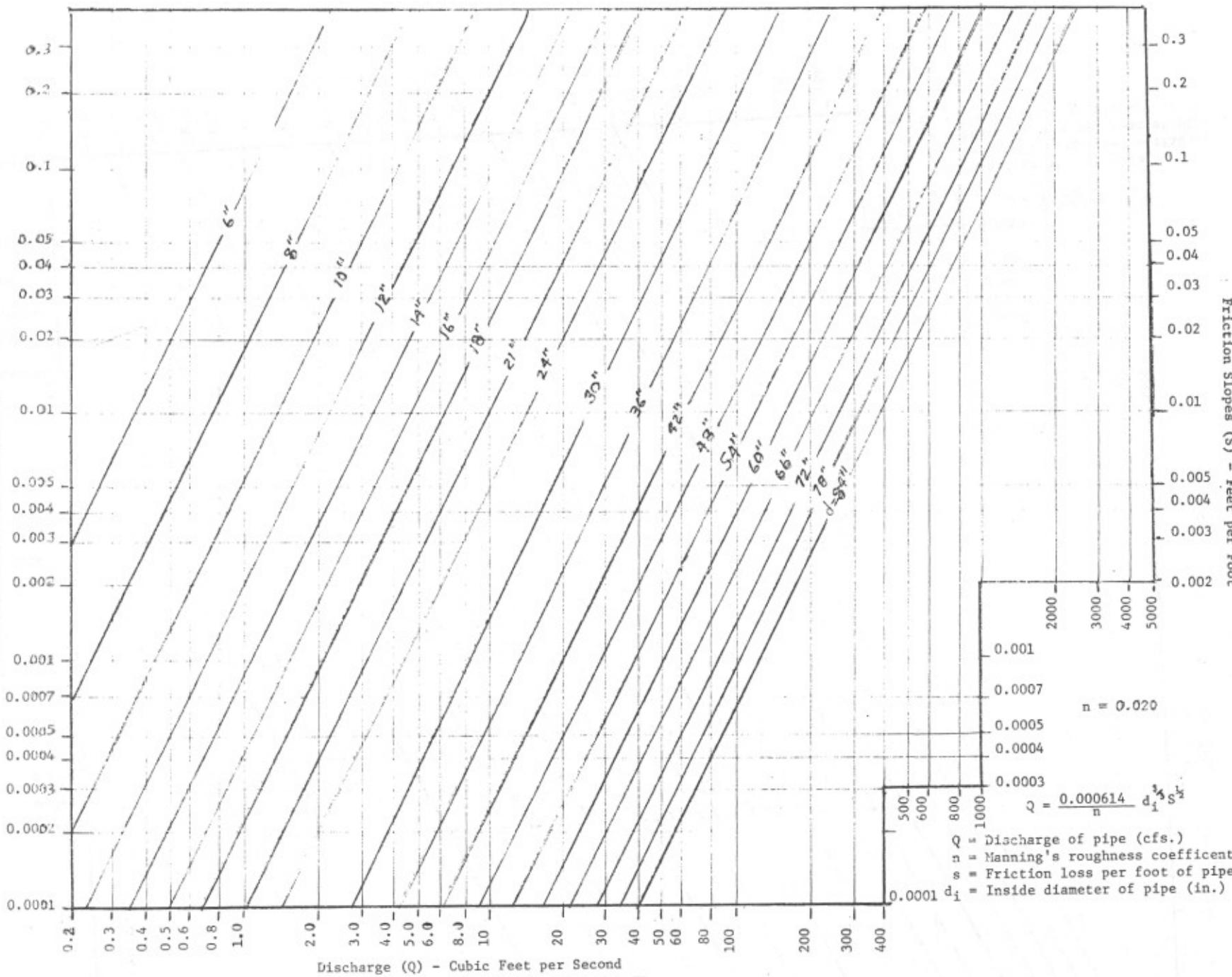
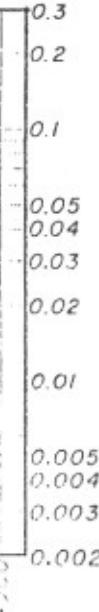


Exhibit 3-5a Discharge of Circular Pipes Flowing Full Manning's n = 0.020 (Sheet 4 of 5)

Friction Slope (s) - Feet per Foot

$$n = 0.025$$

$$Q = \frac{0.000614}{n} d_i^{8/3} s^{5/2}$$

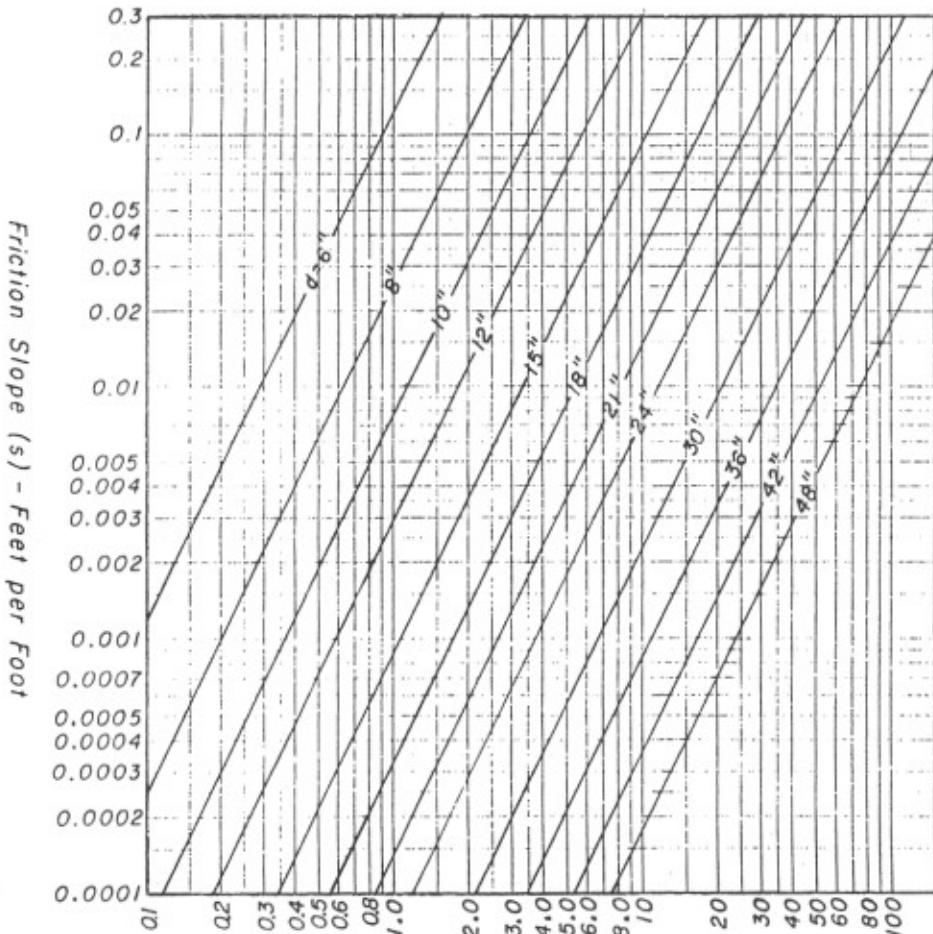
Q = Discharge of pipe (cfs)

n = Mannings roughness coefficient

s = Friction loss per foot of pipe

d_i = Inside diameter of pipe (in.)

Discharge (Q) - Cubic Feet per Second



-3-5a

DISCHARGE OF CIRCULAR PIPES FLOWING FULL

Manning's *n* = 0.025

(Sheet 5 of 5)